Microscopic Aspects of Deadhesion at Metal/Polymer Interfaces

Martin Stratmann[1] and Michael Rohwerder[1]

[1]Max Planck Institut fuer Eisenforschung
Max-Planck-Strasse 1
Duesseldorf D-40237
Germany

The de-adhesion of polymers from metallic substrates is usually based on electrochemical reactions at the metal/polymer interface. In particular, in the case of cathodic delamination oxygen is reduced at the delamination front and reactive intermediates which are formed during the electrochemical reduction destroy the organic backbone of the polymer layer thereby diminishing the adhesive strength between the substrate and the coating.

In recent years, the Scanning Kelvin Probe (SKP) has proven to be a useful tool for the investigation of delamination of polymer coatings [1]. The typical resolution is usually not better than 20 micrometer. This is usually sufficient to detect local anodes and cathodes, to follow the reaction kinetics and therefore to elucidate the principle reaction mechanism.

However, a more microscopic or even nanoscopic view of the reaction at the buried interface is still missing. For example, localized forms of corrosion such as pitting corrosion or filiform corrosion are extremely dependent on existence and character of intermetallic particles in the matrix material. Often these particles are of micrometer or even submicrometer size. Also, delamination is often not purely cathodic or anodic. In many cases, a cathodic front precedes an anodic one, as e.g. in the case of constant exposure delamination from zinc surfaces. In other systems, the delamination seems to be purely anodic but it may just as well be that a cathodic front precedes over a microscopic distance. Furthermore, the delamination mechanism may change as a consequence of changing exposure conditions, e.g. cycling active/passive transitions (cycling wet/dry conditions) often result in altering the nature of the delamination from cathodic to anodic behaviour.

AFM in the Kelvin mode (SKPFM) [2] permits the study of fundamental aspects of delamination with submicroscopic resolution on specially prepared model samples. In this way it is possible to study the very initial stages of delamination and also the details at the delamination front, i.e. the reaction zone. The processes in this very delamination front are of ultimate interest and are the subject of current research [3].

Detailed information has been obtained on the dimension of the reaction zone as well as the influence of surface imperfections on the reaction mechanism. In combination with high-resolution spectroscopic methods such as IR-Microscopy and TOF-SIMS, a detailed understanding of the different delamination mechanisms could be derived and will be discussed within the framework of the results obtained with the conventional Scanning Kelvin Probe.

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